Title of Investigation:

Control Center in the Classroom

Principal Investigator:

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Other In-house Members of Team:

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External Collaborators:

None

Initiation Year:

2004

Aggregate Amount of Funding Authorized in FY 2003 and Earlier Years:

None

FY 2004 Authorized Funding:

$30,000

Actual or Expected Expenditure of FY 2004 Funding:

In-house: $55,000 for equipment purchases;
Contracts: $25,000 /Swales Aerospace

Status of Investigation at End of FY 2004:

To be continued in FY 2005 with additional (expected) FY 2005 Director's Discretionary Fund funding of $50,000

Expected Completion Date:

September 2005

Purpose of Investigation:

The Education Flight Projects Office (EFPO) has routinely provided flight opportunities to students who want to fly their experiments on scientific balloons and sounding rockets. Through these valuable, yet limited flight opportunities, EFPO has reached thousands of students over the years. While greater ingenuity has allowed us to reach more students per flight using these carrier systems, we realize that we can further expand participation.

The goal of this investigation is to inspire and excite large numbers of students by providing them with "hands-on" opportunities to control and monitor flight experiments in their classrooms. The project is to develop a Web-based system that can distribute launch and onboard video, flight telemetry, and ground-tracking data over the Internet. Through the system, hundreds and even thousands of students can monitor flight experiments and, in some cases, control them over the Internet.

FY 2004 Accomplishments:

The baseline system design and development is complete. The baseline system includes:

- Database-driven telemetry ingest and dissemination subsystem
- Web-based telemetry plotting subsystem
- Live webcast of launch and onboard video subsystem
- Post-mission video and telemetry playback subsystem

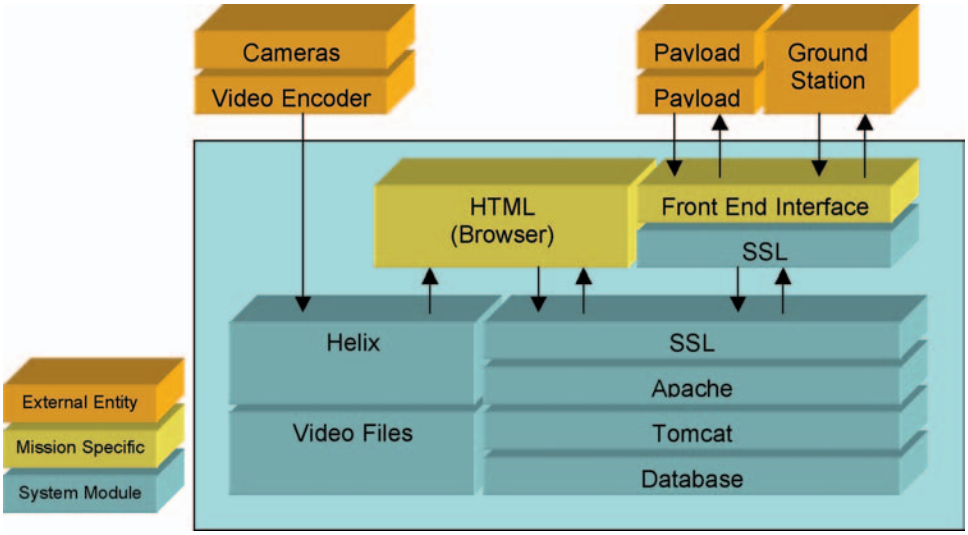

Figure 1. System architecture

Figure 1 depicts the Control Center in the Classroom system architecture. The system consists of several commercial off-the-shelf (COTS) products, including a video encoder and a Webcast system, open-source software (Apache/Tomcat Web server and MySQL database), and several in-house developed modules.

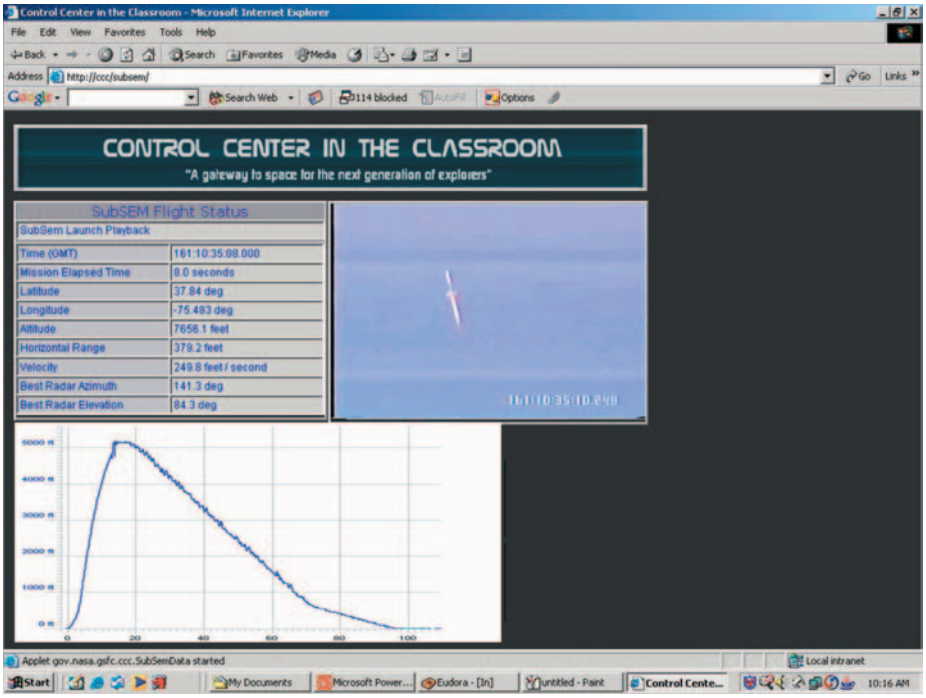

Figure 2. User interface

Figure 2 depicts a sample of the Web-based user interface for students to view and monitor flight status of the mission over the Internet.

Prototype tests of the *Control Center in the Classroom* system were conducted during the spring and summer in support of three education flight missions—Small-scale Educational Rocket Initiative (SERI), Student Experiment Module–Balloon (SEM-B), and Sub-Orbital Space Experiment Module (SubSEM). SERI is a student-built, high-powered hybrid rocket that carries student payloads launched at NASA Wallops Flight Facility; SEM-B was a scientific balloon mission launched at Fort Sumner, New Mexico, and SubSEM was a sounding rocket mission launched at Wallops Island. All three missions carried multiple student experiments. Live video of the launches was broadcast over the Internet. Subsets of the telemetry as well as ground-tracking data also were made available on the Internet during the missions.

During the prototype tests, it was discovered that video and telemetry sent over the Internet were out-of-sync when they reached the end users. The time delay was as much as 30 seconds in some cases. This was due to the fact that video broadcast over the Web uses a buffering technique that causes a substantial delay. Telemetry sent simultaneously with the corresponding video can reach its destination virtually instantly. This issue is now under investigation and plans are being made to remedy the situation.

Figure 3. Students preparing the SERI launch

Web-based commanding capability is currently being added to the system. A meeting has been held with personnel from the Enterprise IT Security Branch (Code 297) to discuss the security techniques and implementation of commanding over the Internet.

Planned Future Work:

Once the commanding capability is complete, Control Center in the Classroom will become a fully functional system ready to support a wide variety of missions. Unique mission interface modules still need to be developed on a per-mission basis.

A series of test missions have been lined up for 2005 in support of Cosmo Cam, an educational instrument flying on the Ultra-Long Duration Balloon (ULDB). Cosmo Cam consists of multiple onboard cameras that look at the Earth's atmosphere. Students will be controlling and monitoring these cameras from the ground over the Internet.

Summary:

In the past, most educational flight projects required students to travel to the NASA control centers to support flight missions. Traveling prevented many students from participating in mission operations due to travel expenses and schedule conflicts. Control Center in the Classroom, an Internet-based control center, lets students be directly involved with their flight projects because it removes geographical limitations. Control Center in the Classroom brings the operations environment into the classroom.

In addition, access to multiple users fosters partnerships, data sharing, and removes limits on the potential amount of direct student involvement. The capability creates the possibility of real-time student co-investigation during any NASA mission. Control Center in the Classroom also enables parents and the community to follow their children's accomplishments. The payoff to NASA is that we can now more cost-effectively reach students and the education community.

Providing hands-on opportunities to large numbers of students who participate in flight missions and inspiring and exciting them to get interested in science and technology are the criteria for success. This past year's efforts have demonstrated the viability of integrating live video and mission data in a Web-accessible format for widespread distribution. Test audiences also have indicated this to be an effective tool for garnering interest and enthusiasm in NASA's space missions.

Some of the technical risks associated with this project include: (1) synchronizing video Webcast and telemetry distribution, and (2) supporting extremely large audiences simultaneously. While these improvements are still needed for the concept to realize its full potential, the foundation has been laid for an educational tool of great promise.